

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS (NON-GFE)

PART 1 - GENERAL

1.1 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
1. Institute of Electrical and Electronics Engineers (IEEE)
 - a. IEEE C57.12.80 Standard Terminology for Power and Distribution Transformers
 2. National Electrical Manufacturers Association (NEMA)
 - a. NEMA ST 1 Specialty Transformers (Except General Purpose Type)
 - b. NEMA ST 20 Dry-Type Transformers for General Applications
 3. Underwriters Laboratories (UL)
 - a. UL 506 Standard for Specialty Transformers

1.2 GENERAL REQUIREMENTS

- A. Section 26 05 00, "COMMON WORK RESULTS FOR ELECTRICAL" applies to work specified in this section.
- B. Certification of previous tests on similar units under actual conditions may be submitted for impulse tests, temperature rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.
- C. Equipment and performance data shall be submitted for distribution transformers including resistance measurements, impedance, efficiencies and voltage and load losses at rated currents.
- D. Equipment foundation data for distribution transformers shall include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.
- E. Transformers shall have copper windings, K13-rated and 80 Degree C rise, 200% neutral for critical lugs, serving Equipment Rooms.

1.3 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES:"
- B. The following shall be submitted for distribution transformers:
 - 1. Connection Diagrams
 - 2. Fabrication Drawings
 - 3. Installation Drawings
- C. Product Data:
 - 1. Equipment and Performance data and Equipment Foundation Data shall be submitted for distribution transformers.
- D. Manufacturer's catalog data shall be submitted for the following items:
 - 1. Distribution Transformers
 - 2. Dry-Type Distribution Transformers
- E. Test Reports: Test reports shall be submitted for the following tests on distribution transformers in accordance with the paragraph entitled, "Field Testing," of this Section.
 - 1. Power Factor Tests
 - 2. Insulation Resistance Tests
 - 3. Insulation Power Factor (Doble) Tests
- F. Certificates: Certification of previous tests on similar units (type-testing) under actual conditions may be submitted for impulse tests, efficiencies, temperature-rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.
- G. Operation and Maintenance Data: Operation and Maintenance Manuals shall be submitted for the following equipment:
 - 1. Dry-Type Distribution Transformers

1.4 FACTORY TESTING

- A. Tests on transformers shall comprise the manufacturer's standard tests including resistance measurements of all windings; ratio tests; polarity and phase-relation tests; no-load loss at rated voltage; impedance; voltage and load loss at rated current; insulation power factor (Doable) tests, and dielectric tests.

1.5 DRAWINGS

- A. Connection diagrams shall be submitted for distribution transformers indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system or portion of system with another, and internal tubing, wiring, and other devices.

- B. Fabrication drawings shall be submitted for distribution transformers consisting of fabrication and assembly details to be performed in the factory.
- C. Installation drawings shall be submitted for distribution transformers in accordance with the paragraph entitled, Installation, of this Section.

PART 2 - PRODUCTS

2.1 EQUIPMENT STANDARDS

- A. Dry-Type Distribution Transformers: General-purpose dry-type transformers for connection to low-voltage distribution circuits of 600 volts or less and the supply of current for lighting and power loads shall be two-winding, 60-hertz, self-contained, self-cooled, Class AA in accordance with NEMA ST 20.

- 1. Insulation system limiting temperature shall be in accordance with the following table, with a temperature rise of:

Dry-Type	Maximum Rise by Resistance	Reference Temperature
K-13	80 degrees C	80 degrees C
All Other	115 degrees C	115 degrees C
Do Not Use	150 degrees C	150 degrees C

- - B. Efficiencies: Transformers shall comply with Class I Efficiency Levels for distribution transformers specified in table 4-2 of the 'Guide for Determining Energy Efficiency for Distribution Transformers' Published by the National Electrical Manufacturers Association (NEMA TP-1-2002)." Efficiency shall be tested in accordance with NEMA TP-2.
 - C. Taps: Transformers smaller than 15 KVA shall have 2 taps at 5%. Transformers 15 KVA and larger shall have 4 taps at 2.5%; 2 above and 2 below full-rated voltage.
 - D. Windings: All transformer windings shall be copper.

2.2 FACTORY FINISH

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 - A. Transformers shall be provided with the manufacturer's standard paint finish when used for most indoor installations.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Arrange equipment to provide adequate spacing for access and for cooling air circulation. Examine walls and floors for suitable mounting conditions where transformers will be installed.
- B. Dry type transformers shall be installed on resilient vibration-isolating mountings and connected with flexible metallic conduit to prevent transmission and amplification of sound.
- C. Pad-mounted distribution transformers shall be installed on precast or poured-in-place concrete pads and shall be grounded to a ground grid. Construct concrete bases not less than four inches larger in both directions than supported unit and four inches high.
- D. Identify transformers and install warning signs according to Division 26 Section 26 05 53 "IDENTIFICATION FOR ELECTRICAL SYSTEMS".
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not furnished, use those specified in UL 486A and UL 486B.
- F. Final electrical connections to transformer shall be with flexible metal conduit (except service transformers).
- G. Provide vibration eliminators to minimize vibration transmission via structure. Vibration eliminator shall be as manufactured by Eliminator Company Inc., Long Island City, New York or approved equal.
- H. Do not use expansion bolts to fasten the transformer to the structure.
- I. Locate wiring compartment at bottom to ensure termination of the cable leads at lowest temperature level. Conduit entrances shall be the lower portion of each end with this area suitably marked.
- J. Transformer secondary winding neutral, core and enclosure shall be grounded in accordance with the latest National Electrical Code requirements.
- K. Disconnects for transformers shall be installed by contractor if required by NEC tap rules for transformers. Disconnects shall meet Specification 26 28 16 2.2.

3.2 FIELD TESTING

- A. Transformers shall be tested in accordance with IEEE Std 62.
- B. Insulation-Resistance Tests: Transformer windings shall be given an insulation-resistance test using the following test set versus voltage level criteria:
 - 1. Dry type 480- to 600-volt transformers - 1,000-volt test set
 - 2. Dry type 240-volt and below transformers - 500-volt test set

- C. Readings shall be recorded every 15 seconds for the first minute and every minute thereafter for 10 minutes. Resistance between phase conductors and ground shall be no less than the following:
 - 1. Dry type below 600 volts - 200 megohms
- D. Insulation Power Factor (Doable) Tests: Transformer windings shall be given an insulation power factor test and winding excitation test in accordance with ANSI IEEE C57.12.90. Insulation power factor shall for new dry type units can have power factors up to 5.0 percent and still be acceptable.
- E. Acceptance: Final acceptance shall depend upon the successful performance of the equipment under test. Transformers shall not be energized until recorded test data have been approved by the Contracting Officer. Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database".

END OF SECTION 26 22 00

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SECTION 26 24 16 – PANELBOARDS (NON-GFE)

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes lighting and power panelboards, and associated auxiliary equipment rated 600 V or less.

1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.

1. FAA Specifications and Standards

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| a. | FAA ORDER 6950.2 | Electrical Power Policy Implementation at
National Airspace System Facilities |
| b. | FAA-C-STD-1217f | Electrical Work, Interior |

2. Federal Standards (FS)

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| a. | FS WC-375 | Circuit Breakers, Molded Case, Branch Circuit
and Service |
| b. | FS WP-115 | Panel, Power Distribution |

3. International Electrical Testing Association (NETA)

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| a. | NETA ATS | Acceptance Testing Specifications for Electric
Power Distribution Equipment and Systems |
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4. National Electrical Manufacturers Association (NEMA)

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|----|------------|---|
| a. | NEMA AB1 | Molded Case Circuit Breakers and Molded Case
Switches |
| b. | NEMA PB1 | Panelboards |
| c. | NEMA PB1.1 | General Instructions for Proper Installation,
Operation, and Maintenance of Panelboards
Rated 600 Volts or Less |

5. National Fire Protection Association (NFPA)

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| a. | NFPA 70 | National Electrical Code |
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6. Occupational Safety and Health Administration (OSHA)
 - a. 29 CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
7. Underwriters Laboratories (UL)
 - a. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - b. UL 489 Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
 - c. UL 50 Enclosures for Electrical Equipment
 - d. UL 67 Panelboards

1.3 DEFINITIONS

- A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

1.4 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES."
- B. Shop Drawings: From manufacturers of panelboards including dimensioned plans. Show tabulations of installed devices, major features, and voltage rating. Include enclosure type with details for types other than NEMA Type 1; bus configuration and current ratings; short-circuit current rating of panelboard; features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.
 1. Panel Schedules
- C. Product Data: Each type of panelboard, accessory item, and component
- D. Test Reports
 1. Written Test Report
 2. Written report of field tests and observations certified by the testing organization.
- E. Certificates
 1. Qualification Data
 2. Qualification data for field-testing organization certificates, signed by the Contractor, certifying that the organization complies with the requirements specified in "QUALITY ASSURANCE" below.
- F. Operation and Maintenance Data: Maintenance data for panelboard components, for inclusion in Operating and Maintenance Manual instructions specified in Section 01 78 23, "OPERATION AND MAINTENANCE DATA." Include instructions for testing circuit breakers.

1.5 QUALITY ASSURANCE

- A. Components and installation shall comply with NFPA 70, NEMA PB1 and UL 50. Overcurrent protective devices (OCPD) shall be provided in accordance with NEMA AB1 and UL 489.
- B. Listed and Labeled: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in NFPA 70 Article 100. Listing and labeling agency qualifications as defined in 29 CFR 1910.7.

1.6 EXTRA MATERIALS

- A. Keys: Furnish two spares of each type for panelboard cabinet locks.
- B. Touch-up Paint for Panelboards: One 1/2-pint container.

PART 2 PRODUCTS

2.1 PANELBOARD FABRICATION

- A. Panelboards shall be circuit breaker equipped, dead-front type, and shall conform to FS WP-115, type I, class 1. All switchboards and panelboards shall be as manufactured by Square D. Equipment shall conform to the sizes and settings as determined by the Protective Device Coordination Study. See Section 26 05 73 "OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY" for requirements.
- B. Enclosures: UL 50, galvanized steel, flush- or surface-mounted cabinets as indicated. Provide cabinets with a factory applied painted finish. Panelboards shall be listed and labeled in accordance with UL 67, and shall conform to the latest requirements of NFPA 70 and NEMA PB1, type 1, class 1, unless otherwise indicated to meet environmental conditions at installed locations.
- C. Directory Frame: Metal with plastic cover, mounted inside each panelboard door.
- D. Bus: Hard drawn copper of 98 percent conductivity to meet UL 67 temperature rise limits, and have a current density of 1000 amperes per square inch. Bus bars shall be sequenced-phased, and rigidly supported by high impact resistant, insulating bus supporting assemblies to prevent vibration or short circuits. Solderless terminations shall be suitable for copper, UL-listed wire or cable and shall be tested and listed in conjunction with appropriate UL standards.
- E. Phase Bus Bars: Shall be silver plated copper or tin plated copper.
- F. Neutral Bus Bars: Shall be copper or plated copper, and insulated from panelboard.
- G. 208Y/120V Critical and Essential Equipment Panels: Neutral bus shall have 200 percent ampacity rating of phase bus.
- H. Capacity: As indicated on drawings. Minimum of 1 lug for each phase of each overcurrent protective device.

- I. Ground and Neutral Buses: Provide with mechanical connectors; one connector for each pole of panel. Minimum of 2 (for each ground and neutral) buses for every electronics panel.
- J. Main and Neutral Lugs: Compression type.
- K. Neutral Bar: The neutral bar shall be fully rated and capable of being located in either corner of the enclosure at the line end to facilitate conductor termination and shall be insulated from panelboard. Neutral bus shall be 200% rated for all panels served by K-13 transformers.
- L. Equipment Ground Bus: Ground bus shall be copper, fully rated, and adequate for feeder and branch-circuit equipment ground conductors with 25 percent additional space for future conditions. Lugs shall be sized to accommodate grounding conductors shown on plans. The ground bus shall be securely bonded to the cabinet and shall be separate from the neutral bus. The number of terminations shall be equal to the number of poles in the panelboard. The ground bus bar shall be structurally integral to the panelboards, or attached to the panelboard with a bolt, nut, and lockwasher. If ground bus bar is mounted to enclosure with screw threads only, (i.e., tapped blind hole), a separate bolted ground lug shall be installed on the panelboard and bonded to the ground bus bar. Bond conductor shall have same current carrying capacity as the largest equipment grounding conductor terminated to the ground bus bar.
- M. Short Circuit Rating: Panelboards shall be fully rated in AIC. See drawings for AIC rating. Minimum 10,000 AIC at 120/208 VAC and 14,000 AIC at 277/480 VAC.
- N. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.
- O. Panelboard Special Features: Include the following special features.
- P. Hinged Front Door in Door Construction: Entire front trim hinged to box with standard door within hinged trim cover (one piece front with two doors). The smaller door, when open, provides access to device handles and rating labels and shall be lockable. The larger door, when open, provides access to conductors and wiring terminals and shall be lockable. Door hinges shall be continuous piano hinges which are welded to the door(s) and bolt on front. All door hinges shall be concealed.
- Q. Channel/Wiring Space: Shall be 4 inches wide for power feeders up to and including 100 amperes, 6 inches wide for power feeders over 100 amperes and up to and including 225 amperes, and 8 inches wide for power feeders over 225 amperes and up to 600 amperes.
- R. Skirt for Surface-Mounted Panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, and floor.
- S. Subfeed: Overcurrent protective device or lug provision.
- T. Door Locks: Doors shall have flush-type cylinder locks and catches. All locks in the project shall be keyed alike, and two keys shall be furnished with each lock.
- U. Series Rating: Series rated panelboards are not acceptable.

2.2 OVERCURRENT PROTECTIVE DEVICES

- A. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices and interrupting capacity rating to meet available fault current as indicated on the drawings.
 - 1. Molded-Case Circuit Breaker: NEMA AB1, UL 489, FS WC-375 and molded case with minimum rating in accordance with the short circuit and coordination study as per FAA ORDER 6950.2.
 - 2. Bolt-on breaker type. Stab-in and plug-in types are not acceptable.
 - 3. Quick make, quick break connections with mechanical trip free switching mechanism.
 - 4. Inverse time, thermal overcurrent trip.
 - 5. Instantaneous magnetic trip.
 - 6. Thermal trip calibrated for 40 degrees C ambient temperature.
 - 7. Provide breakers with number of poles, voltage rating, current rating, and frame size as indicated on the drawings.
 - 8. Multiple circuit breakers shall have an internal, common trip mechanism; trip-indicating feature; single-pole breakers shall be full size modules.
 - 9. Two and three pole breakers shall be sized in multiples of a single-pole breaker. Branch circuits shall be connected to the individual circuit number, as indicated on the drawings. UL marked as suitable for use with 75 degree C wire; trip-indicating feature; single-pole breakers shall be full size modules.
- B. Minimum Rating: 10,000 AIC for 120/208 volt systems, and 14,000 for 277/480 volt systems.
- C. Circuit Breakers: 110 A and larger; shall have trip units interchangeable within frame size.
- D. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
- E. Electronic Trip Unit Circuit Breaker: RMS Sensing; field replaceable rating plug with the following field trip adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long and short time pickup levels.
 - 3. Long and short time adjustments.
- F. Spare breakers: where space is available, provide 10% spare circuit breakers. Coordinate type, size, and rating with COTR.

2.3 ACCESSORY COMPONENTS AND FEATURES

- A. Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 GENERAL

- A. Comply with manufacturer's requirements in accordance with the direction of the COTR. Install to withstand forces for the UBC Seismic Zone indicated in Section 26 05 48, "VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS."

3.2 INSTALLATION

- A. Install panelboards and accessory items according to NEMA PB1.1. Mounting heights, top of trim shall be no higher than 72 inches above finished floor, unless otherwise indicated. Mount plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish. Circuit directory to include installed circuit loads after balancing panelboard loads. The directory shall be arranged so that typed entries simulate circuit breaker positions in the panelboard. Obtain approval of the COTR before installing. Install filler plates in unused spaces. Arrange wiring conductors in panelboard gutters into groups, and bundle and wrap with wire ties after completing load balancing. Ensure NFPA 70 working space and dedicated electrical space are maintained during installation of panelboards. Do not install in a location that will violate NFPA 70.

3.3 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS." Label each panelboard with engraved laminated plastic or metal nameplates mounted with corrosion-resistant screws, as specified in Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS." Provide panelboards with nameplates indicating the panel name, system voltage, and phase.
- B. Example: Panel EPLA-1051-A: 208Y/120V, 3-phase, 4-wire.

3.4 GROUNDING

- A. Make equipment grounding connections for panelboards as indicated in Section 26 05 26, "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS." Provide ground continuity to main electrical ground bus as indicated.
- B. Equipment Ground Bus: Ground bus shall be copper, fully rated and adequate for feeder and branch-circuit equipment ground conductors with 25 percent additional space for future conditions. Lugs shall be sized to accommodate grounding conductors shown on plans.
- C. The ground bus bar shall be structurally integral to the panelboard or attached to the panelboard with a bolt, nut and lockwasher.

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals, including grounding connections, in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.6 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as indicated. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits. Make continuity tests of each circuit.

- B. Visual and Mechanical Inspection: Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual. Check panelboard mounting, area clearances, and alignment and fit of components. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
- C. Electrical Tests: Perform pole to pole and pole to ground and to neutral insulation resistance tests with 500 volt DC megger. Insulation resistance shall be minimum of 50 megohms. Perform test with breakers mounted, in the ON position, and not connected to external circuits. Ground resistance test on equipment ground connections. Test main and subfeed overcurrent protective devices.

3.7 ADJUSTING

- A. Set field-adjustable switches and circuit breaker trip ranges as indicated and provide a chart showing the settings used.

3.8 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt and debris. Touch up scratches and marred finishes to match original finish.

3.9 COMMISSIONING

- A. After substantial completion, conduct load-balancing measurements and circuit changes. Perform measurements during a period of normal working load as advised by the Contracting Officer's Technical Representative. Perform load-balancing circuit changes during normal load period. Record all load readings before and after changes and submit test records. After load balancing, modify identifications of relocated branch circuit conductors to comply with requirements of Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS." Revise record drawings to show modifications. Difference between phase loads exceeding 20 percent at any one panelboard is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

END OF SECTION 26 24 16

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SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes various types of receptacles, connectors, multi-outlet assemblies, wall switches, and finish plates.
- B. This Section includes requirements for the furnishing and installing of fire rated wiring devices. Furnish and install all fire rated wiring devices and associated hardware as shown on the Contract Drawings and as hereinafter specified. All devices shall be heavy-duty specification grade with an intumescent insert material allowing for 0 to 100-percent visual fill of conductors. The same manufacturer shall supply all furnished fire rated devices and associated hardware.

1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
 - 1. Federal Standards (FS)
 - a. FS WC-596 General and Associated Detailed Specifications:
Connector, Plug Receptacle, and Cable Outlet,
Electrical Power
 - 2. Institute of Electrical and Electronics Engineers (IEEE)
 - a. IEEE C62.41 Recommended Practice for Surge Voltages in
Low-Voltage AC Power Circuits
 - 3. National Electrical Manufacturers Association (NEMA)
 - a. NEMA WD-1 General Requirements for Wiring Devices
 - 4. National Fire Protection Association (NFPA)
 - a. NFPA 70 National Electrical Code
 - 5. Occupational Safety and Health Administration (OSHA)
 - a. 29 CFR 1910.7 Definitions and Requirements for a Nationally
Recognized Testing Laboratory (NRTL)
 - 6. Underwriters Laboratories (UL)

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| a. | UL 1472 | Solid-State Dimming Controls |
| b. | UL 20 | General Use Snap Switches |
| c. | UL 498 | Electrical Attachment Plugs and Receptacles |
| d. | UL 943 | Ground Fault Circuit Interrupters |

1.3 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES."
- B. Product data for each product specified.
- C. Operations and Maintenance Data: Prepare and distribute operations and maintenance data as specified in Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70, for devices and installation.
- B. Listed and Labeled: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed. The Terms "listed" and "labeled" are as defined in NFPA 70, Article 100.
- C. Listing and Labeling Agency Qualifications: Listing and Labeling Agency must be a NRTL as defined in 29 CFR 1910.7.
- D. Fire-rated devices shall bear the UL Classification marking. Devices shall be tested in accordance with ASTM E 814 (ANSI/UL 1479).

1.5 COORDINATION

- A. Wiring Devices for Government Furnished Equipment (GFE): Match devices to plug connectors for GFE. Device plates shall be stainless steel, brushed finish. Convenience receptacles shall be brown; computer receptacles shall be ivory; receptacles for essential circuits shall be red; and receptacles for critical circuits shall be orange.
- B. Cord and Plug Sets: Match cord and plug sets to equipment requirements.

PART 2 - PRODUCTS

2.1 WIRING DEVICES

- A. Comply with NEMA WD-1 and UL approved specification grade.
- B. Enclosures: Interior shall be NEMA 1 Equivalent, except as otherwise indicated. Exterior receptacles shall be mounted in waterproof cast outlet boxes with waterproof covers.

- C. Receptacles: All receptacles shall be specification grade in accordance with NEMA WD-1. Wiring terminals shall be of the screw-type. Receptacles with push-in connections or a combination of screw-type and push-in connectors are not acceptable.
 - 1. Straight-Blade: Except as otherwise indicated, comply with FS WC-596 and Specification Grade of UL 498. Provide NRTL labeling of devices to verify compliance.
 - a. Rated 20 amperes at 125 and 250 volts AC. 125 volt AC receptacles shall have NEMA WD-1 type 5-20R configuration.
 - b. Specification Grade with body of fire resistant non-absorptive thermoplastic material.
 - c. 2-pole, 3-wire grounding type with polarized parallel slots.
 - d. Side wired with two screws for each terminal and one screw for grounding.
 - e. Grounding pole connected to mounting yoke.
 - f. Outlet grounding shall be accomplished by the installation of a #12 AWG green insulated equipment ground conductor from the ground bus in the panel board to the receptacle grounding screw of the receptacle. A green pigtail #12 AWG conductor shall also be installed from the receptacle grounding screw to the grounding lug on the outlet box.
 - 2. Special Receptacles: NEMA as indicated on drawings.
- D. Weatherproof Receptacles: Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening that can be closed while a device plug is inserted. Provide caps with a spring-hinged flap. Receptacle shall be UL-listed for use in "wet locations".
- E. Ground-Fault Circuit Interrupter Receptacles: UL 943, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFCI devices.
- F. Wall Switches
 - 1. Snap Switches: AC switches, NRTL listed and labeled as complying with UL 20 and with FS WC-596. Single-pole and three-way wall switches shall be specification grade, rated 120/277 volts, and shall be fully rated 20 amperes, AC only. Wire terminals shall be of the screw type. Switches with push-in connections or a combination of screw-type and push-in connections are not acceptable. Switches shall be the quiet-operating type. Finish color shall be ivory.
- G. Device Plates: Single and combination types that mate and match with corresponding wiring devices. Color and finish as indicated. Features include the following:
 - 1. Plate-Securing Screws: Metal with heads colored to match plate finish.
 - a. Material for Finished Spaces: Brushed stainless steel with beveled edge.
 - b. Material for Unfinished Spaces: Raised type galvanized steel.
 - 2. Wet Locations: Plates installed in wet locations shall be gasketed.
 - 3. Telephone and Communications Outlets: Shall be provided with a blank coverplate unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies plumb and secure, with alignment tolerances of 1/16-inch. Install wall plates when painting is complete. Protect devices and assemblies during painting. Receptacles shall be installed 18 inches above finished floor, unless noted otherwise. Wall switches shall be installed 48 inches above finished floor, unless noted otherwise.
- B. Arrangement of Devices: Except as otherwise indicated, mount flush with long dimension vertical, and grounding terminal of receptacles at bottom. Group adjacent switches under single, multi-gang wall plates. Install switches up or to left for ON position. Mount receptacles in uniform position and same polarity.
- C. Wall Switches: Not more than one switch shall be installed in a single gang position. Where switches have grounding terminals, they shall be grounded with a green grounding pigtail connected from the switch grounding screw directly to the grounding lug on the outlet box where the green equipment grounding conductor is terminated. Install unshared neutral conductors on line and load side of dimmers according to the manufacturer's written instructions.
- D. Device Plates: Plates shall be installed with all four edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plates installed in wet locations shall be gasketed. Use of sectional type device plates shall not be permitted.

3.2 IDENTIFICATION

- A. Comply with Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS." For receptacles identify the panelboard and circuit and number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on both faces of plate and durable wire markers or tags within outlet boxes.

3.3 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 26 27 26

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SECTION 26 28 13 FUSES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Fuses.

1.2 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract.

B. Product data for each fuse type. Include the following:

1. Descriptive data and time current curves.
2. Let through current curves for fuses with current limiting characteristics.
3. Coordination charts and tables and related data.
4. Disconnect applications

C. Maintenance data for tripping devices.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70 "National Electrical Code" for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

C. Single Source Responsibility: All fuses shall be the product of a single manufacturer.

1.4 EXTRA MATERIALS

A. Furnish the following extra materials that match products installed, packaged with protective covering for storage, and with identification labels clearly describing contents.

B. Spare Fuses: Furnish quantity equal to 100 percent of each fuse type and size installed, but not less than 1 set of 3 of each type and size. Provide 2 spare sets of fuses for each fusible device. Provide spare fuses for any part of the power system that is GFE. Provide fuse cabinet in each building to store spare fuses. Locate per FAA Resident Engineer's direction.

PART 2 PRODUCTS

2.1 PLUG FUSES

- A. Type: UL 198F, Type S, dual element, time delay.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1 nonrenewable cartridge fuse, class as specified or indicated, current rating as indicated, voltage rating consistent with circuit voltage.
- B. Main Service: In accordance with the drawings, Class L fast acting BUSS or approved equal.
- C. Feeders: Class RK5, time delay.
- D. Motor Branch Circuits: Class RK5, time delay.
- E. Other Branch Circuits: Class RK5, time delay.
- F. Control Circuits: Class CC, time delay.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install fuses in fusible devices as indicated. Arrange fuses so that fuse ratings are readable without removing fuse.
- B. Install spare fuse cabinet where indicated.
- C. Provide fuse storage box as directed by the COTR.

3.2 IDENTIFICATION

- A. Install typewritten labels on the inside door of each fused switch to indicate fuse replacement information.

END OF SECTION 26 28 13

SECTION 26 28 16 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes individually mounted switches used for feeder and equipment disconnect switches; feeder overcurrent protection; and motor disconnect switches.

1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.

1. FAA Specifications and Standards

- | | | |
|----|--------------------|--|
| a. | FAA Order 6950.2 | Electrical Power Policy Implementation at National Airspace System Facilities. |
| b. | FAA Order 6950.27 | Short Circuit Analysis and Protective Device Coordination Study. |
| c. | FAA Standard 1217f | Electrical Work Interior |

2. International Electrical Testing Association (NETA)

- | | | |
|----|----------|---|
| a. | NETA ATS | Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems |
|----|----------|---|

3. Manufacturers Association (NEMA)

- | | | |
|----|----------|--|
| a. | NEMA KS1 | Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum) |
|----|----------|--|

4. National Fire Protection Association (NFPA)

- | | | |
|----|---------|--------------------------|
| a. | NFPA 70 | National Electrical Code |
|----|---------|--------------------------|

5. Occupational Safety and Health Administration (OSHA)

- | | | |
|----|---------------|--|
| a. | 29 CFR 1910.7 | Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL) |
|----|---------------|--|

6. Underwriters Laboratories (UL)

- | | | |
|----|---------|---|
| a. | UL 486A | Wire Connectors and Soldering Lugs for Use with Copper Conductors |
|----|---------|---|

1.3 SUBMITTALS

The following shall be submitted in accordance with 013300 SUBMITTAL PROCEDURES:

- A. Product Data
 - 1. Switches
- B. Test Reports
 - 1. Field Testing
 - 2. Field test reports indicating and interpreting test results.
- C. Operations and Maintenance Data
 - 1. Prepare and distribute operations and maintenance data as specified in Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70 for components and installation.
- B. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.
- C. Single Source Responsibility: All enclosed switches and circuit breakers shall be product of a single manufacturer and shall be coordinated with Section 26 00 01, "GENERAL PROVISIONS FOR GOVERNMENT-FURNISHED EQUIPMENT (GFE)."
- D. Listed and Labeled: Provide disconnect switches specified in this Section that are listed and labeled. The terms "Listed" and "Labeled" are as defined in NFPA 70, Article 100.
- E. Listing and Labeling Agency Qualifications: A NRTL as defined in 29 CFR 1910.7.
- F. Available Fault Current: All provided gear from this Section shall be suitable for the available fault current in the area of use.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide disconnect switches by Square D Co.

2.2 DISCONNECT SWITCHES

- A. Switches shall be of heavy duty type and the voltage and current ratings indicated on the drawings, and each shall be capable of interrupting the locked rotor current of the motor for which it is to be used. The locked rotor current will be assumed to be 10 times the full rated load current. Switches shall be the quick-make, quick-break type. Except for ground lugs which shall be bonded to the housing, parts shall be mounted on insulating bases to permit

replacement of any part from the front of the switch. All current carrying parts shall be of high conductivity copper unless otherwise specified, and shall be designed to carry rated current without excessive heating. Switch contacts shall be silver tungsten or plated to minimize corrosion, pitting and oxidation and to assure suitable conductivity.

- B. Enclosed, Non-Fusible Switch: NEMA KS1, type heavy duty, lockable handle, with 2 padlocks.
- C. Enclosed, Fusible Switch, Below 800 Amperes: NEMA KS1, type heavy duty, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position. Provide rejection type fuse clips with switches.
- D. Spare Fuses: Provide 2 sets of spare fuses for each fusible device.
- E. Enclosures: NEMA KS1, type 1, unless otherwise specified or required to meet environmental conditions of installed location.
 - 1. Outdoor Locations: Type 4X, stainless steel.
 - 2. Other Wet or Damp Indoor Locations: Type 4X, stainless steel.

2.3 MOTOR DISCONNECT SWITCHES

- F. Motor Disconnect: Provide each motor with a disconnecting means and a manually operated switch as shown on the drawings or when required by NFPA 70.
- G. Single Phase Motors: Provide a single-pole or double-pole toggle switch, rated only for AC, for motor capacities less than 30 amperes, providing that the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches in locations as indicated, according to manufacturer's written instructions. Install disconnect switches and circuit breakers level and plumb. Install wiring between disconnect switches, control and indication devices. Connect disconnect switches and components to wiring system and to ground as indicated and instructed by manufacturer. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A. Identify each disconnect switch according to requirements specified in Section 26 05 53, "Identification for Electrical Systems." Ensure NFPA 70 working space and dedicated electrical space are maintained. Do not install in a location that will violate NFPA 70.

3.2 FIELD QUALITY CONTROL

- A. Testing: After installing disconnect switches and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

- B. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, for disconnect switches. Certify compliance with test parameters. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 ADJUSTING

- A. Set field-adjustable disconnect switches trip ranges as indicated.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish.

END OF SECTION 26 28 16

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SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated volts and less.

1.2 REFERENCE STANDARDS

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.

B. Federal Specifications (FS)

- | | | |
|----|-------------|---|
| 1. | FS QQ-W-343 | Wire, Electrical, Copper (Uninsulated), with Notice 1 |
| 2. | FS W-S-610 | Splice Connectors |

C. National Fire Protection Association (NFPA)

- | | | |
|----|---------|--------------------------|
| 1. | NFPA 70 | National Electrical Code |
|----|---------|--------------------------|

D. National Electrical Manufacturers Association (NEMA)

- | | | |
|----|-----------|---|
| 1. | NEMA WC3 | Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy |
| 2. | NEMA WC50 | Ampacities, Including Effect of Shield for Single Conductor Solid Dielectric Power Cable 15kV through 69 kV |
| 3. | NEMA WC70 | Non-Shielded Power Cable 2000 V or Less |
| 4. | NEMA WC71 | Standard for Nonshielded Cables Rated 2001-5000 Volts |
| 5. | NEMA WC74 | 5-46 kV Shielded Power Cable |

E. Underwriters Laboratories (UL)

- | | | |
|----|---------|--|
| 1. | UL 486A | Wire Connectors and Soldering Lugs for Use with Copper Conductors |
| 2. | UL 486C | Standard for Splicing Wire Connectors |
| 3. | UL 486E | Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors |

F. American Society for Testing and Materials (ASTM)

1. ASTM B 8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
2. ASTM D 1000 Standard Test Method for Pressure-Sensitive Adhesive-Coated Tapes used for electrical and electronic applications.

G. International Electrical Testing Association (NETA)

1. NETA ATS Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems

H. National Electrical Contractors Association

1. NECA Standard of Installation

I. Occupational Safety and Health Administration (OSHA)

1. 29 CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)

1.3 SUBMITTALS

- A. The following shall be submitted in accordance with Section 03 30 00, "CAST-IN-PLACE CONCRETE."
- B. Test Reports: Field test reports indicating and interpreting test results relative to compliance with performance requirements of testing standard.
- C. Operation and Maintenance Data: Prepare and distribute operations and maintenance data as specified in Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

1.4 QUALITY ASSURANCE

- A. Testing Firm Qualifications: An independent testing firm shall meet OSHA criteria for accreditation of testing laboratories, 29 CFR 1910.7, or shall be a full member company of the International Electrical Testing Association (NETA).
- B. Testing Firm's Field Supervisor Qualifications: A person currently certified by the NETA National Institute for Certification in Engineering Technologies to supervise on-site testing specified in PART 3.
- C. Components and Installation: Comply with NFPA 70, for components and installation.
- D. Listed and Labeled: Provide products specified in this Section that are listed and labeled. The terms "Listed" and "Labeled" as defined in NFPA 70, Article 100.
- E. Listing and Labeling Agency Qualifications: A NRTL as defined in 29 CFR 1910.7.

- F. Installer Qualifications: Cable splices shall be performed by experienced and qualified cable splices. The workman shall be licensed if required by the authority having jurisdiction.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate layout and installation of cable with other installations. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Contracting Officer's Technical Representative.

PART 2 - PRODUCTS

2.1 BUILDING WIRES AND CABLES

- A. Specified Applications: UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in PART 3.
- B. Rubber Insulation: Conform to NEMA WC3.
- C. Thermoplastic Insulation: Conform to NEMA WC70, NEMA WC71, and NEMA WC74.
- D. Stranded Conductors: Solid conductor for 10 AWG and smaller; stranded conductor for larger than 10 AWG. Stranded conductors rating shall be tin coated, ASTM B 8, Class B.
- E. Wire and Conduit Sizes: All wire and conduit sizes are based on copper insulated conductors with 75 degrees C temperature rating and ambient temperature of 30 degrees C. Minimum conduit size shall be 3/4".
- F. Sizes: Minimum 12 AWG. Minimum 10 AWG for 120 volt circuits where circuit length (one way) exceeds 75 feet from source, and 10 AWG for 277 volt circuits where circuit length (one way) exceeds 150 feet from source. Communication systems wiring size shall be in accordance with manufacturer's requirements. Fire alarm and control systems wiring size shall be in accordance with manufacturer's requirements or as specified in Section 28 30 00, "MASTER FIRE ALARM SYSTEM."
 - 1. Stranded conductors may be used with wire compression connectors or a pressure washer type lug.
 - 2. Conductor Type
 - 3. Soft drawn, annealed copper (aluminum conductors are not acceptable).
 - 4. Power conductors shall be single conductor type.
 - 5. Control interconnection between equipment shall be jacketed type multiconductor.
 - 6. Instrumentation conductor shall be twisted pair, shielded, jacketed type.
 - 7. Conductors used for lighting and receptacle branch circuits shall be single conductor type.
- G. Conductor Color Codes: Refer to Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS" for conductors No. 4 AWG and larger, where factory color-coding is not available. Feeder conductors to panels and three phase circuits shall be factory color coded as follows:
 - 1. 208/120 (240) Volt System:
 - a. Phase A: Black

- b. Phase B: Red
 - c. Phase C: Blue
 - d. Neutral: White
 - e. Ground: Green
- 2. 480/277 Volt System:
 - a. Phase A: Yellow
 - b. Phase B: Brown
 - c. Phase C: Orange
 - d. Neutral: Gray
 - e. Ground: Green
- 3. Single-phase branch circuits shall be factory color coded as stated above, or identified in accordance with Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS."
- 4. Control cables shall be IAW NEMA WC50
- 5. DC power cables shall be as follows:
 - a. Plus: red color and identified with "+" symbol.
 - b. Minus: black color and identified with "-" symbol.
 - c. N: white (if used).
- H. Un-insulated Conductors: Un-insulated conductors shall be copper and comply with FS QQ-W-343.

2.2 CONNECTORS AND SPLICES

- A. UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, and type and class for applications and for service indicated. Select to comply with project's installation requirements and as specified in PART 3.
- B. Connectors, Splice Sleeves, and Terminal Lugs: Wire and cable connectors, lugs, and sleeves shall be in compliance with UL 486A, and the following:
 - 1. For splices of 10 AWG and smaller building wires in lighting circuits, use tin plated copper compression type connector caps with nonflammable, self-extinguishing insulation grip with temperature rating equal to that of conductor insulation.
 - 2. Use ring tongue compression type terminators with insulated barrel on all stranded conductors used in control wiring.
 - 3. Crimp type connectors are not permitted on solid conductors.
- C. Insulating Tape: ASTM D 1000. As a minimum, rate equal to conductor insulation. Rubber tape shall be silicon rubber with silicon pressure sensitive adhesive.
- D. Bundling Straps: Nylon straps with a locking hub or head on one end and a taper on the other.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine raceway and building finishes to receive wires and cables for compliance with installation tolerances and other conditions. Verify that the duct or conduit is open, continuous, and clear of debris before installing cable. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Feeders: Type THHN/THWN, copper conductor 75 degrees C insulation, in raceway.
- B. Indoor Branch Circuits: Type THHN/THWN, copper conductor, 75 degrees C in raceway. Use this conductor for lighting and receptacle circuits in dry locations only.
- C. Exterior Branch Circuits: Type THWN, copper conductor, 75 degrees C insulation, in raceway.
- D. Service Entrances: Type XHHW conductor rated for SE, USE or USE-2, single conductors in raceway.

3.3 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA. Pull conductors into raceway simultaneously where more than one is being installed in same raceway.
 - 1. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation, and must be non-flammable.
 - 2. Use pulling means; including fish tape, cable, rope, and basketweave wire/cable grips that will not damage cables or raceway.
 - 3. Bend to radii not less than the minimum bending recommended by manufacturer or 12 times the outer diameter of cable. Do not exceed the pulling tension recommended by manufacturer.
 - 4. All box connectors shall have insulated throat.
- B. Cable shall be installed in a manner to prevent harmful stretching of the conductor, injury to the insulation or damage to the outer protective covering. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible. The ends of cables shall be sealed with moisture-seal tape before pulling, and it shall be left sealed until connections are made.
- C. Conductor Splices: Keep to a minimum.
- D. No splices shall be allowed on critical circuits and feeders.
- E. Splices shall be made only at outlets, junction boxes, or accessible raceways.
- F. Wire nuts may only be used to splice conductors sized No. 10 AWG and smaller.

- G. Compression connectors shall be used to splice conductors No. 8 AWG and larger.
- H. All splices, including those made with insulated wire nuts, shall be insulated with electrical tape or heat-shrink tubing to a level equal to that of the factory insulated conductors.
- I. Splicing of ungrounded conductors in panelboards is not permitted.
- J. Splices shall be made with solderless connectors conforming to UL 486A, UL 486C, UL 486E and FS W-S-610.
- K. Install splices and insulating tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- L. Use splice and tap connectors that are compatible with conductor material.
- M. Splice methods and material shall be of a type recommended by the manufacturer of the splicing material for the particular type of cable being spliced and shall be approved by the Contracting Officer's Technical Representative prior to installation.
- N. Wiring at Outlets: Install with at least 6 inches of slack conductor at each outlets.
- O. Connecting Outlets and Components: Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.
- P. Cable/Conductor Installation: Cables/Conductors sized 250 kCMIL and greater shall be installed with the sue of a hydraulic cable bender. Cable supports shall be required for stress relief. A splice shall not be pulled into a duct or conduit under any circumstance.
- Q. Neutral and Ground: Separate neutral and ground wires shall be provided for each over current protection device. Each branch circuit shall have its own neutral and ground conductor. Common neutral or ground is not acceptable. Neutral conductors shall extend from the neutral bus where the phase conductors originate. Install conductors only after the raceway system is complete.
- R. Electrical Identification: Install electrical identification devices specified in Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS" at terminations, immediately after installing wires and cables.

3.4 FIELD QUALITY CONTROL

- A. Testing, General:
 - 1. Cables shall be tested prior to installation and again upon completion of the installation. Testing shall be accomplished before connection is made. Tests shall be performed in the presence of the Contracting Officer's Technical Representative.
 - 2. Upon installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

3. Perform each visual and mechanical inspection and electrical test state in NETA ATS. Certify compliance with test parameters.
 4. Test wire and cable for continuity or circuitry, and also for short circuits.
- B. Insulation Resistance Tests: Feeder and branch circuit insulation tests shall be performed after installation, but before connection to equipment.
1. Conductors shall test free from short circuits and grounds, and have a minimum phase-to-phase and phase-to-ground insulation resistance of 30 mega-ohms when measured with a 500-volt DC insulation resistance. The Contractor shall submit a letter type test report to the COTR prior to final inspection of the work. The report shall list the tests performed and results obtained.
 2. Apply the test voltage for at least one minute after motor reading his stabilized.
- C. Malfunctioning Products: Correct malfunction products at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

ATTACHMENT

Megger Test Report:

600 V CABLE INSULATION AND CONTINUITY TEST (power/control wire & cable)

Project Name _____ Date _____ Sheet No. _____ of _____
Project No. _____ Address _____

NOTE: 500 VOLT MEGOHMMETER, MEGGER ALL PHASES, RECORD MINIMUM READING

Panel No. Ckt. No. Feeder No.	VOLTS	A-B	A-C	B-C	A-N	B-N	C-N	A-G	B-G	C-G	N-G	Supervisor O.K.

END OF SECTION 26 05 19

SECTION 26 32 13 - ENGINE GENERATORS (GFE)

PART 1 - GENERAL

1.1 SUMMARY

- A. Installation Requirements: This section includes the installation requirements for Government Furnished (GFE) packaged diesel engine generator system, including: engine generator set, radiator, cooling system, load bank, exhaust system, starting system, starting batteries, battery charger, muffler, day tank, and automatic transfer switch. The Contractor shall be responsible for receiving Government Furnished Equipment on site, proper storage prior to installation, setting in place, anchoring of this equipment, and completing all electrical and mechanical corrections. The Contractor is responsible for installation, termination and final connection of power feeders and control wiring associated with the installation of this equipment. The Contractor is responsible for furnishing and the installation of the fuel supply and return system, including the exterior fuel tank.

1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
1. American Society of Mechanical Engineers (ASME)
 - a. SME B15.1 Safety Standard for Mechanical Power Transmission Apparatus
 2. International Electrical Testing Association (NETA)
 - a. NETA ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems
 3. National Fire Protection Association (NFPA)
 - a. NFPA 110 Standards for Emergency and Standby Power Systems
 - b. NFPA 37 Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
 - c. NFPA 70 National Electrical Code
 4. Underwriters Laboratories (UL)
 - a. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors

1.3 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES:"
- B. Shop Drawings: The Government shall provide to the Contractor a completed and approved shop drawing of the actual equipment that will be provided. Upon receipt of the equipment on site, the Contractor shall verify the accuracy of this shop drawing and report any discrepancies to the Contracting Officer's Technical Representative.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Perform work to meet or exceed the requirements of NFPA 70 and other applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction. Notify the Contracting Officer's Technical Representative of known or probable code violations discovered during contractor performance. Do not proceed with the work until violations have been resolved.
- B. Delivery: In writing, 30 days before needed on sit, contractor shall receive E/G on or near that date and is responsible for storage.

PART 2 - PRODUCTS

2.1 PACKAGED ENGINE GENERATOR SYSTEM

- A. This equipment will be furnished by the Government. The Contractor is responsible for receiving this equipment on site, storage of this equipment prior to installation, setting in place, and anchoring of this equipment. The contractor shall be also responsible for all mechanical, piping, and exhaust connections to this equipment. The Contractor shall be responsible for the coordination of work, to include proper sizing of equipment housekeeping pads and location of power and control wiring termination points within the equipment. Coordination with Government furnished shop drawings of the equipment.

2.2 ENGINE - GFE

- A. Fuel: Fuel oil, Grade DF-2.
- B. Silencer - GFE

2.3 EXHAUST SYSTEM

- A. The engine exhaust system shall be installed by the Contractor to discharge combustion gases quickly and silently with minimum restriction. System including silencer shall be designed for minimum restriction, and in no case shall backpressure exceed the maximum specified by the manufacturer for engine size required.
 - 1. Piping shall be supported and braced to prevent weight or thermal growth being transferred to the engine and flexible expansion fittings. Support dampers and springs shall be included where necessary to isolate vibration.

2.4 FUEL OIL STORAGE

- A. Refer to specifications Section 23113 Facility Fuel Oil Piping.

2.5 CONTROL AND MONITORING

- A. GFE except as indicated.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION - GFE

2.7 LOAD BANK – GFE

- A. Load bank controller
- B. Load bank overcurrent and fault protection

2.8 REMOTE SWITCHES

- A. Remote emergency stop switch: GFE.

2.9 AUTOMATIC TRANSFER SWITCH - GFE

2.10 Battery Charger and Batteries - GFE

2.11 TERMINATION LUGS

- A. Provide termination lugs as required to facilitate the termination of power conductors and control wiring within this equipment. Comply with UL 486A. Contractor shall furnish and install all necessary heavy-duty electrical lugs for the project specific wiring configuration in drawings. Lugs may be necessary for, but not limited to, automatic transfer/bypass isolation switch, engine generator, and load bank. Contractor shall ensure lug configuration is possible with GFE.

PART 3 - EXECUTION

3.1 GENERAL

- A. Comply with the manufacturer's requirements, construction drawings, and specification.

3.2 INSTALLATION

- A. Anchor generator set and other system. Provide anchorage according to manufacturer's written instructions, unless otherwise indicated. Maintain minimum workspace around components according to manufacturer's shop drawings and NFPA 70. Provide power circuits, control wiring, and connections as shown on the drawings. Contractor shall provide E/G with all fluids necessary for startup including, but not limited to, battery electrolyte, engine coolant, engine oil, etc., as recommended by the manufacturer.

- B. Conform to the requirements for electrical equipment installations specified herein, and in strict accordance with NFPA 70, and manufacturer's installation drawings and wiring. During and after installation, until the system is accepted by the Contracting Officer, Contractor shall protect equipment, from moisture, dust, and contamination. Upon completion of the Engine Generator installation, Contracting Officer and Engine Generator manufacturer's technical representative will inspect the installation for contract compliance. Contractor shall correct installation deficiencies as directed.
- C. Contractor shall notify Contracting Officer in writing at least 14 calendar days prior to completion of the Engine Generator system installation. At this time the Contracting Officer, will schedule the manufacturer's technical representative to inspect the completed installation.
- D. Installation Inspection: Engine Generator technical representative and the Contracting Officer, in the presence of the Contractor, will inspect the completed installation. The Contractor shall correct construction or installation deficiencies as directed.
- E. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- F. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- G. Install packaged engine generator on vibration isolators as shown on the drawings.
- H. Install Schedule 40, stainless steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.
 - 1. Install condensate drain shutoff valve to muffler drain outlet .
- I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
- J. Fluids: Contractor shall supply all fluids including: E/G oil, coolant, battery electrolyte, 90% full above ground diesel tank.

3.3 IDENTIFICATION

- A. Identify system components according to requirement of Section 23 05 53, "IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT" and Section 26 05 53, "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

3.4 FIELD QUALITY CONTROL AND DEMONSTRATION

- A. The Contractor shall have a representative on site during the Government's acceptance testing and demonstration of this equipment to witness the proceedings as well as a technician to correct deficiencies. Anchoring, conduit installation, wiring termination or any other portion of the installation of this equipment that is deemed improper by the Contracting Officer's Technical Representative in conjunction with the equipment's manufacturing representative shall be corrected by the Contractor at no additional expense to the Government.

- B. Tests: All tests of engine generator equipment will be performed by the equipment's manufacturing representative. Contractor has no responsibility for this test other than to schedule and witness them.
- C. Test Failures and Installation Deficiencies: Correct deficiencies identified by tests and prepare for retest. Equipment manufacturer's representative and Contracting Officer's Technical Representative shall retest equipment corrections are made until specified requirements are met.

3.5 COMMISSIONING

- A. Battery Equalization: Equalization charging of battery cells according to manufacturer's written instructions. Record individual cell voltages. Coordinate this work with the equipment manufacturer's representative and Contracting Officer's Technical Representative.

END OF SECTION 26 32 13

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SECTION 26 32 14 – ENGINE GENERATOR RESISTIVE LOAD BANK (GFE)

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes installation and testing requirements for Government Furnished outdoor weatherproof resistive load bank for the facility's stand-by engine generator.

1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
- B. National Fire Protection Association (NFPA)
 - 1. NFPA 70 National Electrical Code

1.3 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, "Submittal Procedures:"
- B. Shop Drawings: Show details of fabrication, wiring, and installation of field-installed portions of systems. Include general arrangement drawing showing locations of auxiliary components in relation to the load bank, and wiring connections, mounting, and support provisions and access, and workspace requirements.
- C. Wiring Diagrams: Show detail of power and control connections differentiating between factory-installed and field-installed wiring.
- D. Operation and Maintenance Data: prepare and distribute operations and maintenance data as specified in Section 01 78 23, "Operation and Maintenance Data."

PART 2 - PRODUCTS

2.1 GENERAL

- A. Equipment described in this section will be furnished by the government. Refer to Section 26 00 01, "General Provisions for Government Furnished Equipment (GFE)".

PART 3 - EXECUTION

3.1 GENERAL

- A. Comply with the manufacturers requirements.

3.2 INSTALLATION

- A. Anchor the load bank on concrete housekeeping bases conforming to Section 03 30 00, "Cast-in-Place Concrete", and Section 23 05 48, Provide anchorage according to manufacturer's written instructions, unless otherwise indicated. Maintain minimum workspace around components according to manufacturer's Shop Drawings and NFPA 70. Provide power circuits and connections as shown on the Drawings.
- B. Supporting Items: Provide sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Sensors and other supporting items are located in engine, generator, or elsewhere as indicated. Where not indicated, locate to suit manufacturer's standard.
- C. Land all control and power in load bank and load bank controller before startup per manufacturer's recommendation. This includes installation of load shed/share CT (shipped loose in load bank) that monitors building load at ATS.

3.3 DEMONSTRATION

- A. Contractor has no contractual responsibility for training requirements for GFE.

END OF SECTION 26 32 14

SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes lightning protection for buildings and associated structures and requirements for lightning protection system components.

1.2 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.

1. FAA Orders and Standards:

- a. FAA-STD-019e, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment

2. Lightning Protection Institute (LPI)

- a. LPI-177 Inspection Guide for LPI Certified Systems.

3. National Fire Protection Association (NFPA)

- a. NFPA 70 National Electrical Code.
b. NFPA 780 Standard for the Installation of Lightning Protection Systems

4. Occupational Safety and Health Administration (OSHA)

- a. 29 CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)

5. Underwriters Laboratories (UL)

- a. UL 96A Installation Requirements for Lightning Protection Systems.

6. FAA-STD-019e

Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES."

- A. Shop Drawings: Shop Drawings detailing lightning protection system, including but not limited to air terminal locations, conductor routing and connections, bonding and grounding provisions.
- B. Test Reports
 - 1. Field Reports
 - 2. Field inspection reports indicating compliance with specified in Section 01 78 23, "OPERATION AND MAINTENANCE DATA."
- C. Qualification Data: For firms and persons specified in "QUALITY ASSURANCE" Article to demonstrate their capabilities and experience. Include data on listing or certification by nationally recognized testing laboratory (NRTL) or trade association. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- D. Operation and Maintenance Data: Prepare and distribute operations and maintenance data as specified in Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

1.4 QUALITY ASSURANCE

- A. Conform to NFPA 780. Conform to UL 96A and provide UL Master Label. Conform to the most stringent requirements of LPI certification of system, and Electrical Testing Lab (ETL) Master Label, indicating system complies with specified requirements.
- B. Installer Qualifications: Engage an experienced installer who is certified by the Lightning Protection Institute as a Master Installer/Designer to install lightning protection system.
- C. Listed and Labeled: Provide products specified in this Section that are listed and labeled by an organization concerned with product evaluations and that can determine compliance with appropriate standards for the current production of listed items. The terms "Listed" and "Labeled" are as defined in NFPA 70, Article 100.
- D. Listing and Labeling Agency Qualifications: A NRTL as defined in 29 CFR 1910.7.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

PART 2 PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Materials: All equipment shall be UL-listed and marked in accordance with UL procedures. All equipment shall be new and of a design and construction to suit the application in

accordance with UL 96A. Bronze and stainless steel may be used for some components. All lightning protection materials shall be Class II, Class I not allowed.

- B. Air Terminals: Air terminals shall be solid copper, unless mounted to aluminum equipment. Copper air terminals may be nickel plated. Air terminal shall be a minimum of 12 inches in height, at least 1/2-inch diameter copper (5/8-inch diameter aluminum where required), and shall have a rounded or "bullet" point. Air terminals shall be located in accordance with the requirements of NFPA 780 and UL 96A. Air terminals shall extend at least 10 inches above the object or area they are designed to protect.
- C. Main Conductors: Perimeter and down conductors shall be minimum class II stranded bare copper as indicated on drawing, and shall meet the requirements given in NFPA 780.
- D. Secondary Conductors: Shall be a minimum class II, to provide secondary or bonding conductors as indicated on drawings. Shall be bare copper.
- E. Hardware: Hardware shall meet the following requirements:
 - 1. Fasteners: Perimeter and down conductors shall be fastened at intervals not exceeding 3 feet. Fasteners shall be of the same materials as the conductor base material or bracket being fastened, or other equally corrosion resistant material. Plastic, galvanized or plated materials shall not be used.
 - 2. Fittings: Bonding devices, cable splices, and miscellaneous connectors shall be suitable for use with the installed conductor and shall be copper or bronze with exothermic weld. Bolt pressure connections of secondary conductors may be acceptable. Cast or stamped crimp type fittings shall not be used.
 - 3. Guards: Guards shall be provided for down conductors located in or next to driveways, walkways or other areas where they may be displaced or damaged. Guards shall extend to at least six feet above, and 1 foot below grade level. Guards shall be Schedule 40 PVC. Bonding numbers shall be the same size as the down conductor. Crimp type fittings shall not be used.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Shall be in accordance with FAA-STD-019e and not violate NFPA 780.

3.2 EXAMINATION

- A. Examine surfaces and conditions, with installer present, for compliance with installation tolerances and other conditions affecting performance of lightning protection system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Installation shall conform to UL 96A. Installer shall provide an Underwriters Laboratories Master Label for the facility. Conform to the most stringent requirements when more than one standard is specified.
- B. Conductor and Conduit Routing: Perimeter and down conductors shall maintain a horizontal or downward course. No bend in a roof or down conductor shall form an incline angle of less than 90 degrees, nor shall it have a bend radius of less than 8 inches.
- C. Down Conductor Terminations: Down conductors shall originate at the air terminals and shall be exothermically welded to a #4/0 AWG copper conductor prior to enter the ground. The #4/0 AWG copper conductor shall enter the ground and be welded to a ground rod that is exothermically welded to the Earth Electrode System. The ground rod shall be buried 18 inches vertically below ground level, and from 2 feet to 6 feet outside the foundation or exterior footing of the building. Provide number of down conductors indicated on drawings.
- D. Down Conductor Location: Conductors shall be in PVC conduit from ground to 6 feet above grade and exposed above 6 feet. Submit system plan which indicates exact location of down conductors, as well as intended equipment locations, to engineer for approval prior to installation. Vertical down conductors shall be tinned copper #4/0 bare.
- E. Contracting Officer's Technical Representative Notification: Notify the Contracting Officer's Technical Representative at least 24 hours before concealing lightning protection system components.
- F. Metallic Bodies Subject to Induced Charges: Metallic bodies that are subject to induced charges from lightning include any isolated metallic body within 6 feet of an exposed lightning protection system element. These metallic bodies shall be bonded to the lightning protection system using UL approval splices, fittings, and conductors. Conductors used for bonding these metallic bodies shall be class II secondary conductors in accordance with NFPA 780.
- G. Exothermic Welds: Only exothermic welds are acceptable below grade.

3.4 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

3.5 FIELD QUALITY CONTROL

- A. Periodic Inspection: Provide the services of a qualified inspector to perform periodic inspections during construction and at its completion, according to LPI-177.
- B. UL Inspection: Apply for inspection by UL as required for UL Master Labeling of System.

3.6 TEST

- A. Upon completion of installation of lightning protection system, test resistance-to-ground with resistance tester. Where tests show resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by treating soil proximity to ground rods with sodium chloride, copper sulfate, or magnesium. Then retest to demonstrate compliance.

END OF SECTION 26 41 13

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SECTION 26 43 13 - TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL
POWER CIRCUITS

PART 1 - GENERAL

1.1 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.

1. American National Standards Institute/ Institute of Electrical and Electronics Engineers/(ANSI/IEEE)
 - a. C62.41 Guide for Surge Voltages in Low Voltage AC Power Circuits
 - b. C62.45 Standard for Testing Procedures and Practices
2. FAA Specifications and Standards
 - a. FAA-STD-19e Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment
3. National Electrical Manufacturers Association (NEMA)
 - a. NEMA LS1 Low Voltage Surge Protective Devices
4. National Fire Protection Association (NFPA)
 - a. NFPA 70 National Electrical Code
5. Occupational Safety and Health Administration (OSHA)
 - a. 29 CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
6. Underwriters Laboratories (UL)
 - a. UL 1283 Electromagnetic Interference Filters
 - b. UL 1449 Transient Voltage Surge Suppressors
 - c. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - d. UL 67 Panelboards

1.2 SUMMARY

This Section includes transient voltage surge suppressors for low-voltage circuits and equipment. Switchgear and panelboards are included.

- A. Transient Voltage Surge Suppressors (TVSS): Surge protection of AC electrical circuits and systems from the effects of lightning induced currents/voltages, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching and radio frequency/electromagnetic interference. Suppression protection for building service entrance as indicated on drawings. Surge protection for all circuits sensing, powering, and controlling devices located or mounted external to the building. The unit shall provide effective high-energy transient voltage suppression, surge current diversion, high-frequency electrical line noise attenuation, and line control in C62.41 environments.
- B. Incoming Secondary Electrical Service: The incoming secondary electrical service entrance conductors shall terminate at the main secondary switchgear's MCB and it shall be protected with a class C3 transient voltage surge suppressor (TVSS)/surge protection device (SPD). The TVSS/SPD device(s) shall be installed as close as possible to the service entrance overcurrent protection device (OCPD) they serve and in accordance with the manufacturer's instructions. All essential power and critical power panelboards and all panelboards supplying exterior circuits such as obstruction lights, exterior convenience outlets, guard shacks, electrical gates, and feeds to other facilities shall be protected by a Class C3 TVSS/SPD installed as close as possible to the panelboard they serve and in accordance with the manufacturer's instructions. Downstream normal utility panelboards as indicated on the drawings shall be protected by a Class B TVSS/SPD installed as close as possible to the panelboards they serve and in accordance with the manufacturer's instructions.
- C. National Airspace System (NAS) Facilities: Surge protective devices shall be installed on all critical and essential panels providing service to NAS operational equipment or supplying exterior circuits. SPDs shall be selected in accordance with the guidance provided in C62.41 and meet the requirements of UL 1449. Devices for panels serving exterior circuits shall be tested for a level C3 application per C62.41. The conduit or conduit nipple connecting the SPD enclosure to the panel enclosure shall be sealed with duct seal or other nonflammable medium to prevent soot from entering the enclosure in the event of SPD failure. The use of potting material in SPDs is strictly prohibited. All SPD components must be accessible for inspection by qualified FAA personnel. The maximum (MCOV) for SPDs located at branch and distribution panels shall be equal to or greater than the maximum (MCOV) of those located at the facility service.
- D. Operational Upset Level: The operational upset level is the transient voltage or energy level that causes an unacceptable change in operating characteristics for longer than 10 milliseconds for analog equipment or a change of logic state for digital equipment.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES."

- E. Product Data

1. Each suppressor category type
2. Submit product descriptions indicating dimensions for each suppressor type and mounting arrangement with required hardware conductor.

F. Test Reports

1. UL certified test data
2. Provide third party testing documentation demonstrating that the device will survive the published maximum surge current rating. Test reports will clearly show that the tests were performed on a COMPLETE device including all necessary fuses, thermal disconnects and monitoring systems.
3. Provide data demonstrating that the device is capable of surviving the specified number of C62.41 Category C3 (10kA) impulses without failure or performance degradation of more than 10 percent.
4. Provide UL 1449 reports as certified by UL. The report shall also include any "Engineering Considerations".
5. Provide a COMPLETE test package per the requirements of NEMA LS1.
6. Field Test Reports
7. Indicate and interpret results for compliance with performance requirements.

G. Operation and Maintenance Data

1. Transient Voltage Surge Suppressors
2. Include in the maintenance manuals. Submit in accordance with Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

H. Closeout Submittals

1. Warranties
2. Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Perform work to meet or exceed the requirements of NFPA 70 and other applicable statutes, ordinances, codes and regulations of Government authorities having jurisdiction. Notify the Contracting Officer's Technical Representative of known or probable code violations discovered during subcontractor performance. Do not proceed with the work until violations have been resolved.
- B. Listed and Labeled: Provide electrically operated equipment specified in this Section that is listed and labeled. The terms "listed" and "labeled" as defined in NFPA 70, Article 100.
- C. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory as defined in 29 CFR 1910.7.
- D. Manufacturer's Qualifications: Surge suppression devices manufactured by a company engaged in the design, development, and manufacture of surge suppression devices for the protection of electrical circuits and electronic equipment with such products in satisfactory use in similar service for not less than 5 years.

- E. Regulatory Requirements: For the purposes of this Specification, IEEE Category C and B locations, shall assume maximum voltage amplitude of 20 kilovolts and a maximum current amplitude to 10 kilo-amperes. Comply with UL 1449.

1.5 WARRANTY

- A. Special Warranty: Special warranties specified in this Article shall not deprive the FAA of other right FAA may have under other provisions of the contract documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the contract documents.
- B. General Warranty: A written warranty, executed by manufacturer, agreeing to repair or replace components of transient voltage surge suppressors that fail in materials or workmanship within the specified period. Warranty period shall be 5 years from date of final acceptance by the FAA. Should suppressors be destroyed by surge(s) or transients, free replacement shall apply during the warranty period.

1.6 MAINTENANCE

- A. Surge suppressor manufacturer shall provide replacement unit or factory certified service and repair for surge suppressor units within 24 hours from time of notification.

PART 2 PRODUCTS

- 2.1 Equipment described in this section will be furnished by the government. Refer to Section 26 00 01, "General Provisions for Government Furnished Equipment (GFE)", Section 26 00 02, "Documentation, Testing, and Training Requirements for Government Furnished Equipment (GFE)", and Section 26 00 03, "List of Government Furnished Equipment," for additional information.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with requirements for installation tolerances, power characteristics, and other conditions affecting performance of transient voltage surge suppressors. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate installation of TVSS system with manufacturers and suppliers of equipment to be protected. Demonstrate and train FAA authorized personnel for service and operation of the systems.
- B. Install TVSS components as indicated on the drawings and in accordance with manufacturer's recommendations, which shall be considered a contractual requirement. Ensure NFPA 70

working space and dedicated electrical space are maintained during installation of panelboards. Do not install in a location that will violate NFPA 70.

3.3 CONNECTIONS

- A. Ground each transient voltage surge suppressor enclosure. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.4 FIELD QUALITY CONTROL

- A. The Contractor shall have a representative on site during the FAA's acceptance testing and demonstration of this equipment to witness the proceedings.

END OF SECTION 26 43 13

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SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.

1. American National Standards Institute (ANSI)
 - a. ANSI C62.41 Recommended Practice on Surge Voltage in Low-Voltage AC Power Circuits
 - b. ANSI C78 Standard for Electric Lamps
 - c. ANSI C82.2 Method of Measurement of Fluorescent Lamp Ballasts
2. FAA Orders and Standards:
 - a. FAA-STD-1217f Electrical Work, Interior
3. Federal Specifications (FS)
 - a. FS JC-30 Cable and Wire, Electrical
 - b. FS WF-414 Fixture, Lighting, Fluorescent
4. National Fire Protection Association (NFPA)
 - a. NFPA 70 National Electrical Code
5. Occupational Safety and Health Administration (OSHA)
 - a. 29 CFR 1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
6. Underwriters Laboratories (UL)
 - a. UL 1570 Fluorescent Lighting Fixtures
 - b. UL 1571 Incandescent Lighting Fixtures
 - c. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
 - d. UL 542 Lampholders, Starters, and Starter Holders for Fluorescent Lamps
 - e. UL 924 Emergency Lighting and Power Equipment
 - f. UL 935 Fluorescent Lamps and Ballasts

1.2 SUMMARY

- A. This Section includes interior lighting fixtures, lamps, ballasts, emergency battery ballast, and accessories.

1.3 DEFINITIONS

- A. Average Life: Time after which 50 percent will have failed and 50 percent will have survived under normal conditions.
- B. Fixture: A complete lighting unit or exit sign. Fixtures include lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply.
- C. Luminaire: Fixture.

1.4 SUBMITTALS

- A. The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES."
- B. Product Data
 - 1. Lighting fixtures
 - 2. Ballasts
 - 3. Emergency ballasts
 - 4. Arrange product data for fixtures in order of fixture designation. Include data on features and accessories; outline drawings indicating dimensions and principal features of fixtures; certified results of independent laboratory tests for electrical ratings and photometric data for fixtures and lamps.
- C. Operation and Maintenance Data
 - 1. Submit in accordance with Section 01 78 23, "OPERATION AND MAINTENANCE DATA."

1.5 QUALITY ASSURANCE

- A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL.
- B. Listed and Labeled: Provide fixtures and accessory components that are listed and labeled for their indicated use and installation conditions on the project. The terms "listed" and "labeled" as defined in NFPA 70, Article 100.
- C. Special Listing and Labeling: Provide fixtures for use in damp or wet locations, and recessed in combustible construction that are specifically listed and labeled for such use.
- D. Listing and Labeling Agency Qualifications: A NRTL as defined in 29 CFR 1910.7.
- E. Ballast Manufacturers Qualifications.

- F. Coordination: Coordinate fixtures, mounting hardware, and trim with ceiling system and other items, including work of other trades, required to be mounted on ceiling or in ceiling space.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
- B. Lamps: Furnish one lamp for every 10 of each type and rating installed. Furnish at least one of each type.
- C. Plastic Diffusers and Lenses: Furnish one for every one hundred of each type and rating installed. Furnish at least one of each type.
- D. Ballasts: Furnish 1 for every 100 of each type and rating installed. Furnish at least 1 of each type.

1.7 WARRANTY

- A. General Warranty: The special warranty specified in this paragraph shall not deprive the Government of other rights the Government may have under other provisions of the contract documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the contract documents.
- B. Special Warranty: Provide a written warranty signed by manufacturer and installer agreeing to replace ballasts against defects in material and workmanship for a period of 5 years from the date of substantial completion. Defective ballasts shall be replaced within the warranty period at no cost to the Government.

PART 2 PRODUCTS

2.1 FIXTURES, GENERAL

- A. Comply with the requirements specified in this Section and lighting fixture schedule indicated on the drawings. The fixtures specified in the lighting fixture schedule on the drawings establish a level of quality and appearance that any substituted fixtures must match or exceed. Substitutions for the specified fixtures will be reviewed by the Contracting Officer's Technical Representative for compliance and approval. All lighting fixtures shall be UL-listed and shall bear the UL label.

2.2 FIXTURE COMPONENTS, GENERAL

- A. Metal Parts: Free from burrs and sharp corners and edges.
- B. Sheet Metal Components: Steel, except as indicated. Components are formed and supported to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors,

frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

- D. Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or water white, annealed crystal glass, except as otherwise indicated.
- F. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- G. Lens Thickness: 0.125-inch minimum, except where greater thickness is indicated.
- H. Fixture Wiring: Thermoplastic insulated copper, rated for 600 volts, in accordance with FS JC-30 and NFPA 70.
- I. EMI and RFI Filters: Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI) filters shall be Sylvania Lighting International (SLI) Cat. No. 89G635, or approved equal.

2.3 SUSPENDED FIXTURE SUPPORT COMPONENTS

- A. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rods.
- B. Hook Hanger: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.4 FLUORESCENT FIXTURES

- A. Fixtures conform to UL 1570. Ballasts conform to UL 935.
- B. Certification: By Electrical Testing Laboratory (ETL).
- C. Labeling: By Certified Ballast Manufacturers Association (CBM).
- D. Type: Class P, high-power factor type except as indicated otherwise. Shall include inherent automatic thermal reset and fuse. Shall be type for use in indoor or type I, outdoor applications.
- E. Sound Rating: A rating, except as indicated otherwise.
- F. Voltage: Match connected circuits.
- G. Minimum Starting Temperature: Low temperature ballast minimum starting temperature shall be 0 degrees F, unless otherwise noted.

- H. Electronic Ballasts: Solid-state, full-light-output, energy-saving type compatible with T8 lamps. Conform to FCC regulations Part 15, Subpart J for electromagnetic interference. Conform to ANSI C62.41. Location Category A2, for resistance to voltage surges for normal and common modes. Ballasts shall operate the lamps in parallel. Ballasts shall be fully encapsulated to ensure maximum thermal and structural integrity.
 - I. Minimum Power Factor: 99 percent.
 - J. Minimum Ballast Factor: 87 percent.
 - K. Minimum Operating Frequency: 20,000 Hz.
 - L. Third Harmonic Content of Ballast Current: Less than 6 percent.
 - M. Total Harmonic Distortion (THD): Less than 10 percent.
 - N. Average Input: The minimum required wattage when tested according to ANSI C82.2.
 - 1. 32 or less watts when operating one F32T8 lamp.
 - 2. 61 or less watts when operating two F32T8 lamps.
 - 3. 93 or less watts when operating three F32T8 lamps.
 - 4. 112 or less watts when operating four F32T8 lamps.
 - O. Minimum Power Factor: 95 percent.
 - P. Minimum Operating Frequency: 20,000 hertz without visible flicker.
 - Q. Maximum Crest Factor: 1.4.
 - R. Dimming Circuitry: Ballasts shall be class 2 and fully isolated from ballast input power.
 - S. Constant Light Output: Ballasts shall maintain constant light output over operating ranges of 200 volts to 320 volts (277V ballasts) 60 Hz.
 - T. Intermediate Trimming Controls: Ballast shall require no intermediate trimming controls between ballast and controlling device.
 - U. Electromagnetic Interference (EMI) Filters: Integral to fixture assembly. Provide 1 filter for each ballast. Suppress EMI as required by MIL STD 461E.
 - V. Lamp Holders: Lamp holders shall have silver plated contacts, and shall conform to UL 542.
 - W. Suspended Fixtures: Pendant-mounted fluorescent fixtures shall conform to FS WF-414 and shall be types indicated on the drawings.
- 2.5 INCANDESCENT FIXTURES
- A. Conform to UL 1571.

2.6 EXIT SIGNS

- A. Conform to UL 924. The letters of exit signs shall be red. The background of internally lighted signs shall be either stenciled metal with a light gray or white color. The letters shall be block lettering at least 4 1/2 inches high with 9/16-inch strokes. Arrows shall be included as indicated and shall be red. Lamps for AC operation shall be light emitting diode (LED) array. All exterior exit signs shall be NEMA-3R rated.

2.7 2.8 EMERGENCY LIGHTS

- A. Emergency lights shall conform to Federal Specification W-L-305, type I, class I, style D or E, with the number of heads as indicated on the drawings. Emergency light sets shall be connected to the wiring system by a cord no more than 3 feet in length to a single receptacle.

B. 2.9 LAMPS

- A. Furnish lamps for all fixtures in accordance with lighting fixture schedule. Conform to ANSI C78 series applicable to each type of lamp. Fluorescent color temperature and minimum color-rendering index (CRI) shall be 3500 K and 85 CRI, except as otherwise indicated. Incandescent lamps shall be rated for 130 volts unless otherwise indicated. Low voltage 50MR16 lamps shall be a minimum of 4,000 hours lamp life, 3050 K color temperature, and beam spread of 24-27 degrees.

2.10 FINISHES

- A. Manufacturer's standard finish applied over corrosion-resistant treatment or primer, free of streaks, runs, stains, blisters, and similar defects. Remove fixtures showing evidence of corrosion during project warranty period and replace with new fixtures.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's written instructions and approved shop drawings.
- B. Support for Suspended Fixtures: Brace pendants and rods over 48 inches long to limit swinging. Support stem-mounted, single-unit, suspended fluorescent fixtures with twin-stem hangers. For continuous rows, use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of chassis, including one at each end.
- C. Lamping: Lamp units according to manufacturer's instructions.

3.2 CONNECTIONS

- A. Electrical connections, all mating surfaces and connections shall be between cleaned bare metal to bare metal surfaces.

- B. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A. External bonding jumpers are not required across lighting fixture flexible conduit.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components. Give advance notice of dates and times for field tests. Provide instruments to make and record test results.
- B. Tests: Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. All fixtures shall be energized upon completion of installation for a period of 72 hours, upon which Contractor shall replace any lamps or ballasts which are not operating properly. Fluorescent lamps with dimming ballasts shall be energized for 100 hours at full brightness before dimming. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly. Report results of test.
- C. Warranty Period: Replace fixtures that show evidence of corrosion during warranty period.

3.4 ADJUSTING AND CLEANING

- A. Clean fixtures after installation. Use methods and materials recommended by manufacturer. Adjust aimable fixtures in the presence of the Contracting Officer's Technical Representative to provide required lighting intensities.

END OF SECTION 26 51 00